

Contents

Preface vii

1 Coordinate Systems 1

- 1-1 Introduction 1
- 1-2 Cartesian Coordinates 1
- 1-3 Plane Polar Coordinates 3
- 1-4 Spherical Polar Coordinates 5
- 1-5 Complex Numbers 7

2 Functions and Graphs 11

- 2-1 Functions 11
- 2-2 Graphical Representation of Functions 12
- 2-3 Roots of Polynomial Equations 21

3 Logarithms 24

- 3-1 Introduction 24
- 3-2 General Properties of Logarithms 24

iv Contents

3-3 Common Logarithms 25

3-4 Natural Logarithms 27

4 Differential Calculus 30

4-1 Introduction 30

4-2 Functions of Single Variables 31

4-3 Functions of Several Variables; Partial Derivatives 36

4-4 The Total Differential 39

4-5 Derivative as a Ratio of Infinitesimally Small Changes 41

4-6 Geometric Properties of Derivatives 45

4-7 Constrained Maxima and Minima 49

5 Integral Calculus 57

5-1 Introduction 57

5-2 Integral as an Antiderivative 57

5-3 General Methods of Integration 58

5-4 Special Methods of Integration 60

5-5 The Integral as a Summation of Infinitesimally Small Elements 64

5-6 Line Integrals 67

5-7 Double and Triple Integrals 70

6 Infinite Series 76

6-1 Introduction 76

6-2 Tests for Convergence and Divergence 77

6-3 Power Series Revisited 81

6-4 Maclaurin and Taylor Series 83

6-5 Fourier Series and Fourier Transforms 85

7 Differential Equations 95

7-1 Introduction 95

7-2 Linear Combinations 96

7-3 First-Order Differential Equations 97

7-4 Second-Order Differential Equations with Constant Coefficients 100

7-5 General Series Methods of Solution 104

7-6 Special Polynomial Solutions of Differential Equations 106

7-7 Exact and Inexact Differentials 113

7-8 Integrating Factors 116

7-9 Partial Differential Equations 117

8 Scalars and Vectors 123

- 8-1 Introduction 123
- 8-2 Addition of Vectors 123
- 8-3 Multiplication of Vectors 126
- 8-4 Applications 128

9 Matrices and Determinants 132

- 9-1 Introduction 132
- 9-2 Square Matrices and Determinants 133
- 9-3 Matrix Algebra 135
- 9-4 Solutions of Systems of Linear Equations 139
- 9-5 Characteristic Equation of a Matrix 141

10 Operators 149

- 10-1 Introduction 149
- 10-2 Vector Operators 151
- 10-3 Eigenvalue Equations Revisited 153
- 10-4 Hermitian Operators 155
- 10-5 Rotational Operators 156
- 10-6 Transformation of ∇^2 to Plane Polar Coordinates 160

11 Numerical Methods and the Use of the Computer 165

- 11-1 Introduction 165
- 11-2 Graphical Presentation 169
- 11-3 Numerical Integration 175
- 11-4 Roots of Equations 179
- 11-5 Fourier Transforms Revisited: Macros 182

12 Mathematical Methods in the Laboratory 193

- 12-1 Introduction 193
- 12-2 Probability 193
- 12-3 Experimental Errors 196
- 12-4 Propagation of Errors 200
- 12-5 Preparation of Graphs 204
- 12-6 Linear Regression 205
- 12-7 Tangents and Areas 207

Appendices 211

- I Table of Physical Constants 211
- II Table of Integrals 211
- III Transformation of ∇^2 to Spherical Polar Coordinates 225
- IV Stirling's Approximation 228
- V Solving a 3×3 Determinant 229
- VI Statistics 230

Answers 232

Index 241

8 Integral Calculus 57

- 8-1 Introduction 57
- 8-2 Integral as an Antiderivative 57
- 8-3 General Methods of Integration 58
- 8-4 Special Methods of Integration 60
- 8-5 The Integral as a Summation 67
- 8-6 Line Integral 67
- 8-7 Surface Integral 67

9 Infinite Series 67

- 9-1 Numerical Methods and the Use of the Computer 67
- 9-2 Tests for Convergence and Divergence 77
- 9-3 Power Series 81
- 9-4 Maclaurin and Taylor Series 82
- 9-5 Numerical Series 85
- 9-6 Fourier Series and Fourier Transform 85

7 Differential Equations 85

- 7-1 Introduction 85
- 7-2 Linear Equations 86
- 7-3 First-Order Differential Equations 87
- 7-4 Second-Order Differential Equations 89
- 7-5 General Series Methods 90
- 7-6 Special Polynomials 90
- 7-7 Partial Differential Equations 90
- 7-8 Exact Equations 90
- 7-9 Homogeneous Equations 90
- 7-10 Linear Equations 90
- 7-11 Trigonometric Equations 90

12 Mathematical Methods in the Laboratory 93

- 12-1 Introduction 93
- 12-2 Probability 93
- 12-3 Experimental Errors 93
- 12-4 Propagation of Errors 93
- 12-5 Preparation of Graphs 93
- 12-6 Linear Regression 93
- 12-7 Tangents and Areas 93

10 Operators 149

- 10-1 Introduction 149
- 10-2 Vector Operators 151
- 10-3 Eigenvalue Equations 151
- 10-4 Hermitian Operators 152
- 10-5 Rotational Operators 156
- 10-6 Transformation of ∇^2 to Plane Polar Coordinates 160

11 Numerical Methods and the Use of the Computer 167

- 11-1 Introduction 167
- 11-2 Graphical Presentation 168
- 11-3 Numerical Methods 172
- 11-4 Roots of Equations 179
- 11-5 Fourier Transforms Revisited: Matrix 182

13 Matrices and Determinants 182

- 13-1 Introduction 182
- 13-2 Addition of Vectors 182
- 13-3 Multiplication of Vectors 182
- 13-4 Applications 182

9 Matrices and Determinants 182

- 9-1 Introduction 182
- 9-2 Square Matrices and Determinants 182
- 9-3 Matrix Algebra 182
- 9-4 Solutions of Systems of Linear Equations 189
- 9-5 Characteristic Equation of a Matrix 191

10 Operators 149

- 10-1 Introduction 149
- 10-2 Vector Operators 151
- 10-3 Eigenvalue Equations 151
- 10-4 Hermitian Operators 152
- 10-5 Rotational Operators 156
- 10-6 Transformation of ∇^2 to Plane Polar Coordinates 160

11 Numerical Methods and the Use of the Computer 167

- 11-1 Introduction 167
- 11-2 Graphical Presentation 168
- 11-3 Numerical Methods 172
- 11-4 Roots of Equations 179
- 11-5 Fourier Transforms Revisited: Matrix 182

12 Mathematical Methods in the Laboratory 93

- 12-1 Introduction 93
- 12-2 Probability 93
- 12-3 Experimental Errors 93
- 12-4 Propagation of Errors 93
- 12-5 Preparation of Graphs 93
- 12-6 Linear Regression 93
- 12-7 Tangents and Areas 93